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Abstract

Though male homosexuality appears to be evolutionarily paradoxical, phenotypic feminization has been offered as a route for three current models positing a genetic basis for male homosexuality. We tested whether facial feminization is observable in gay men in two studies. In Study 1, using two composite images of gay and of heterosexual men, naive participants ($N = 308$) rated the 'gay' face more highly on stereotypically feminine traits and actual femininity and the 'heterosexual' face more highly on stereotypically masculine traits and actual masculinity. In Study 2, faciometrics of 428 internet images of gay ($N = 219$) and heterosexual men were analyzed along six, sexually dimorphic ratios. The faciometrics of gay men were more feminine, both in gestalt terms, and for five of the six individual traits. The studies offer objective support for a more feminized facial phenotype in gay males that is difficult to explain through cultural or behavioral cues.

Keywords: Feminization, faciometric, facial metrics, sexual dimorphism, homosexual men, sexually antagonistic selection, cheekbone prominence, eye mouth eye angle, lip depth.

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The Darwinian Paradox that is male homosexuality represents an enduring problem for evolutionary biologists, as natural selection should select against any process systematically lowering reproductive success. Nevertheless, research suggests that, though this is far from a simple fact (Ross, 1983; Santtila et al, 2009), at least in Western cultures, homosexuality does, indeed, lower offspring production (Bell & Weinberg, 1978; Weinrich, 1987). In attempts, then, to understand the etiology and possible evolutionary basis of homosexuality, a number of evolutionary theories have been offered, including, amongst others, kin altruism (Wilson, 1975, 1978), heterozygote advantage (Miller, 2000) and, to a lesser extent, sexually antagonistic selection (Rice, 1984; Rice & Holland, 1997) and same-sex affiliation theory (Muscarella, 1999, 2000; Rahman & Wilson, 2003).

A number of these theories have, at their core, the suggestion that phenotypic feminization may be involved. Two such theories involve ‘balancing selection’, these being heterozygote advantage (sometimes known as ‘balanced polymorphism’ or ‘overdominance’) and sexually antagonistic selection. In terms of heterozygote advantage, the suggestion is that men heterozygous for homosexual genes may carry a fitness advantage over those homozygous for heterosexual genes. There are a number of possible explanations for this e.g. through superior sperm competition (MacIntyre & Estep, 1993), enhanced sex drive (McKnight, 1997), or suppressed androgenization with resultantly more

feminine personality traits (Miller, 2000; Zeitsch et al, 2008), the latter being a view consistent with female preference for feminized facial features in men (Cunningham, Barbee, & Pike, 1990; Little & Hancock, 2002; Perrett et al, 1998; Rhodes, Hickford & Jeffrey, 2000). That heterosexual, psychologically feminine men have more opposite-sex sexual partners (Zeitsch etc. al, 2008) would be consistent with this theory. Similarly, same-sex affiliation theory (Muscarella, 1999, 2000; Rahman & Wilson, 2003) suggests that ancestral men who were more feminine in behavior and who had bisexual preferences would be better adapted to cope with inter-group and intra-sex aggression (a factor in early hominid life, particularly for men), through same-sex affiliations. Additionally, these feminine characteristics would make the men more attractive to women as prospective fathers and partners, in both ways ultimately improving their fitness.

A further important explanatory theory involving balancing selection is that of sexually antagonistic selection which suggests that homosexuality may be maintained at equilibrium within a population if the disadvantage to one sex is outweighed by the advantage to the other. There is a wealth of supporting evidence here, showing that mothers, aunts and grandmothers of gay men exhibit greater fecundity than mothers of heterosexual men (Blanchard & Lippa, 2007; Camperio-Ciani, Corna & Capiluppi, 2004; Camperio-Ciani, & Pellizzari, 2012; Iemmola, F. & Camperio Ciani, 2009; Camperio Ciani A, Fontanesi L, Iemmola F, Giannella E, Ferron C, & Lombardi, 2012; Rahman, Collins, Morrison, Orrells, Cadinouche, Greenfield & Begum, 2008), as do the relatives of gay men on both

maternal and paternal lines (King et al, 2005). Increased femininity, and hence increased attractiveness, in female carriers of the polymorphic alleles for homosexuality may offer a plausible explanation.

Further theories exist, including steady state mutation (Wilson, 1987) and adaptive bisexuality (Baker & Bellis, 1985, as cited in Rahman and Wilson, 2003). However, of interest to this study is the concept of phenotypic feminization (or gender inversion) as in three of the most important current explanations of male homosexuality, phenotypic feminization is posited as a possible explanatory factor. Whilst recent research has been equivocal with regard to feminization as a satisfactory explanation for the genetic predisposition for male homosexuality (e.g. Zietsch et al, 2008, but see Santtila et al, 2009), further research is needed to clarify this position.

Conclusive functional explanations have therefore proved elusive thus far, however, there has been a contemporaneous search for biological differences between gay and heterosexual men. Indeed, the search for hereditary evidence of homosexuality has flourished through twin and family studies (Bailey & Bell, 1993; Bailey & Pillard, 1991; Bailey, Pillard, Dawood, Miller, Farrer, Trivedi, & Murphy, 1999; Bailey, Pillard, Neale, & Agyei, 1993; Camperio-Ciani, Corna & Capiluppi, 2004; Darwood, Pillard, Horvath, Revelle & Bailey, 2000; Pillard, Poumadere & Carretta, 1982; Pillard & Weinrich, 1986; Santtila, Sandnabba, Harlaar, Varjonen, Alanko, & von der Pahlen, 2008; Zeitch et al, 2008) and, more recently, through investigations into the hereditary material itself, our DNA, and

through linkage analysis (Hamer, Hu, Magnuson, Hu & Pattatucci, 1993; Hu et al, 1995; Mustanski, Dupree, Nievergelt, Bocklandt, Schork & Hamer, 2005; Wang et al, 2012). Additionally, other biological differences between gay and heterosexual men have shown gender atypical markers, including hemispheric differences in brain size (Savic & Lindström, 2008), 2D:4D digit ratio (McFadden & Shubel, 2002; McIntyre, 2003; Manning, Churchill & Peters, 2007), dermal ridges (Hall & Kimura, 1994) and ratio of arm length to height (Martin & Nguyen, 2004).

Perceptions of Sexual Orientation and Accuracy in Judgments

There is good evidence, then, for biological differences in gay and heterosexual men consistent with sexually dimorphic physical characteristics. Additionally, more recent research has demonstrated that gender atypical cues may contribute to perceptions of another's sexuality. For example, stereotypically feminine behavior in a heterosexual man may lead to the (mis)perception that he is gay (Bosson, Prewitt- Freilino & Taylor, 2005; Rieger, Linsenmeier, Gygax, Garcia & Bailey, 2010), whilst the amount of shoulder and hip movement when walking also contributes to perceptions of male homosexuality (Johnson, Gill, Reichman & Tassinari, 2007). Thus gender atypical cues may feed into our 'cultural knowledge' of what it is to be gay, resulting in perceptions of homosexual orientation which may, or may not, be real (Freeman, Johnson, Ambady & Rule, 2010). However, sexual orientation may be accurately assessed by observers through brief observations of non-verbal behavior (Ambady,

Hallahan & Conner, 1999) or with only minimal exposure to facial information either through time constraint (Rule & Ambady, 2008; Rule, Ambady & Hallett, 2009) or through reduction of facial information offered (Rule, Ambady, Adams & Macrae, 2008; Rule et al, 2009). Furthermore, evidence suggests that gender atypical facial cues may be used in these judgments of sexual orientation. For example, using both real and computer generated faces, Freeman et al (2010) demonstrated that the more gender inverted the face (in shape and texture), the more likely targets would be rated as gay or lesbian. However, they also demonstrated that targets that countered stereotypes were reliably mistaken (i.e. that gender atypical heterosexual men or women were taken to be gay or lesbian and that gender typical gay men or lesbians were taken to be heterosexual), suggesting the likelihood of gender-inverted heuristics in perceptions of sexual orientation.

In a similar vein, Hughes and Bremme (2011) investigated morphological facial differences in, and resultant perceptions of, a person's sexual orientation. They found that both actual and perceived homosexuality was related to greater facial asymmetry as well as more feminine faces, at least in terms of a composite of sexually dimorphic traits, if not for individual traits. In other words, Hughes and Bremme argue that accuracy in assessment of homosexuality may be 'less of an issue of specific facial characteristics and more of a gestalt perception of masculinity/femininity' (2011, p. 225).

Similarly, Valentova, Kleisner, Havlíček, and Neustupa (2014) looked at both self-reported sexual orientation and the correlation with perceived sexual orientation and masculinity/ femininity ratings, as well as a geometric morphometric study to look for differences in the facial shapes of gay and homosexual men. Significant differences in geometric morphometrics were reported, with subsequent qualitative appraisal of the images suggesting a smaller nose and philtrum (distance from nose to mouth) in gay men and a shorter distance between the eyes and mouth (distance between pupils and medial center of the mouth) in addition to differences in the shape of the chin (which was more rounded in gay men). Overall, however, (and unlike Hughes & Bremme, 2011), Valentova et al report ‘a mosaic of both feminine and masculine features (2014, p. 359). This was, perhaps, unexpected, and as such quantitative analysis of facial dimensions for further corroboration (or otherwise) of their findings was recommended. In all, then, research to date suggests that phenotypic feminization in gay men may be evident through subtle but discernible differences in gross anatomical facial features, though this may not be seen in every feature or, indeed, every combination of features.

The current study

The growing body of literature in observable difference in gay and heterosexual men increasingly suggests, therefore, that phenotypic feminization may underlie at least one sub-type of male homosexuality, though research on observable difference remains, to varying degrees, open to the possibility that

such differences found may be more reasonably attributable to socialization and sub-cultural norms in, for example, gait and controllable, gendered cues, than to any underlying biological differences (Berger, Hank, Rauzi & Simkins, 2010; Schofield & Schmidt, 2005). The current study explicitly investigates the relationship between homosexual orientation in men and phenotypic facial feminization, and aims to clarify the degree to which facial feminization is both perceived and is actually evident in gay men. In the first study, we create two composite images, one of self-labelling gay and one of self-labelling heterosexual men, thereby producing a prototypical image for both. If phenotypic feminization is a characteristic of male homosexuality, the prototypical image of the gay face should score more highly on stereotypically feminine traits when rated by participants' naïve to the nature of the experiment, whilst the prototypical image of the heterosexual face should score more highly on stereotypically masculine traits. Due to the naivety of the participants regarding the nature of the study, therefore, and unlike previous studies (Hughes & Bremme, 2011; Valentova, et al, 2014), conscious sub-cultural stereotyping should not play a role in judgments relating to the perceived masculinity/ femininity of the gay/heterosexual images to which the participants are exposed.

In the second study we extend a part of the novel research by Hughes and Bremme (2011) and Valentova et al (2014) by investigating sexually dimorphic facial proportions in a larger sample of self-identified gay and heterosexual men. We predict that, as a composite of features, gay men should display more

feminized facial measurements than heterosexual men. Similarly, and building on the Hughes and Bremme (2011) and Valentova et al (2014) studies, we also explore the individual sexually-dimorphic measures for specifically identifiable differences between gay and heterosexual men.

Study 1

Method

Participants.

Three hundred and eight participants, 236 women ($M_{age} = 28.62$, $SD = 10.81$) and 72 men ($M_{age} = 31.43$, $SD = 14.69$) completed the survey. All were recruited either through specialist sites for online psychological research and directed to the host site, PsychData, or through advertising within the host university. Of the latter ($N = 65$), all were Social Science students. No payment or course credits were given. Of the whole group, 88% described their ethnic group or background as White, 3.9 % Asian, 3% multiple ethnicity and the remainder either African, Caribbean or Black, or Other. Consent was obtained from all participants and all were provided with a comprehensive debrief after participation as required by the institutional ethics committee.

Creation of stimuli.

Following established protocols, stimulus materials were created through the face processing software package 'PsychoMorph' (Burt, Perrett & Tiddeman, 2001), a technique that has enabled manipulation of facial dimensions for a

variety of experimental purposes including aging (Nash, Fieldman, Hussey, Leveque & Pineau, 2005), judgments of health (Jones, Little, Penton-Voak, Tiddeman, Burt & Perrett, 2001) and, more recently, judgments of facial attractiveness (Tigue, Pisanski, O'Connor, Fraccaro & Feinberg, 2012). Facial templates are created from images of generally six or more members of any homogenous group, though composites have been created from three images (e.g. Buriss & Little, 2008) and average around 17 images (e.g. Boothroyd et al, 2005; Lobmaier, Sprengelmeyer, Wiffen & Perrett, 2010; Saxton, DeBruine, Jones, Little & Roberts, 2009). The templates are created by the manual marking of 179 specific points including main facial features (e.g. points around the eyebrows, eyes, pupils, nose, mouth etc.) as well as points delineating the facial structure (e.g. jawline, hairline etc.). The final prototypical image is constructed by averaging the position of each delineated point and warping the original images onto these average image points. Whilst the production of such composites without further transformation may increase, through effects of symmetry and averageness, for example, perceived attractiveness of that group over the attractiveness of the individual images that made up the group, such an effect will be equally represented across composites. Thus, composites may be usefully compared with each-other to explore perceptual differences between the groups of interest.

In this study, 13 self labelling gay men ($M_{age} = 22.9$, $SD = 4.31$) and 13 self labelling heterosexual men ($M_{age} = 22.00$, $SD = 3.16$) were recruited through

contacts known to the researchers, through snowball sampling and through local advertising as approved by the host university's review board. As such, the models were self-selecting. The purpose of the study was known to the men who agreed to be photographed. Participants were asked to face forwards with no head slant either laterally or in an upward or downward position and to assume a neutral expression whilst being photographed from a distance of one meter. In order to eradicate any socio- specific cues, Adobe Photoshop CS3 was then employed to standardize the background and the hairstyles of the images obtained of the prototype images (see Fig. 1).

Questionnaire.

Participants were recruited to take part in a study investigating 'perceptions of the personalities of averaged male faces'. Thus, participants were naïve to the true nature of the study until the debriefing. Having completed the requisite demographic information, participants were then presented simultaneously with the two prototype images, but here labelled only as 'Image A' and 'Image B' (see Fig. 1) with no additional, explanatory information. It was decided not to counterbalance the images as we felt this might cause confusion in scoring over numerous characteristics. Thus, the gay composite was consistently 'Image A' and the heterosexual composite 'Image B'.

Participants were asked to rate both images across the 60 personality characteristics from the BEM Sex Role Inventory (BSRI; Bem, 1974). Ratings for each characteristic were requested on a new 'page' on a seven-point Likert scale

from 1 (*least agree*) to 7 (*most agree*). Twenty of these were stereotypically masculine (e.g. assertive, independent), 20 were feminine (e.g. affectionate, sympathetic) and 20 were neutral characteristics (e.g. happy, reliable) and were included to deflect attention from ‘masculinity’ and ‘femininity’. Participants were also asked as part of the survey to rate both images for what will be referred to as ‘specific masculinity’ (i.e. How masculine is this man?), ‘specific femininity’ (i.e. How feminine is this man?), and physical attractiveness (i.e. How physically attractive is this man?), again on a seven-point Likert scale but with ‘*least masculine/ most masculine*’, ‘*least feminine/ most feminine*’ and ‘*least attractive/ most attractive*’ as anchor points as appropriate.

Data Analyses.

Mean scores for masculine and feminine characteristics were calculated for both the gay and the heterosexual composite images. Paired-samples *t*-tests were used to analyze perceptions of masculine and feminine characteristics in the first case and ‘specific masculinity/ femininity’ in the second, with the independent variable being the composite gay or heterosexual images. These analyses were then also performed by participant gender to assess potential gender differences in perceptions. Additionally, and again using paired-samples *t*-tests, differences in perceived attractiveness was also investigated. Alpha was set to .05 in all analyses and *p* values presented are two-tailed.

Results

Analysis of BEM’s gendered characteristics.

The first analyses considered differences between the gay and heterosexual composite images in perceptions of masculinity and femininity in gendered characteristics. In terms of masculinity, the heterosexual composites received significantly higher ratings ($M= 4.86$, $SD= 0.81$) than the gay composite ($M=4.18$, $SD= 0.69$) ($t(307) = 11.30$, $p < .001$, $d= 0.64$). By contrast, in terms of femininity the gay composites received significantly higher ratings ($M= 4.97$, $SD= 0.79$) than the heterosexual composite ($M= 3.36$, $SD = 0.75$) ($t(307) = 23.13$, $p < .001$, $d= 1.32$). There were, therefore, significant differences in perceptions of the characteristics of the averaged faces, with the gay face being rated as significantly higher in feminine characteristics and significantly lower in masculine characteristics than the heterosexual face.

The data were then analyzed by gender of participant. When rated by men the heterosexual composites received significantly higher ratings ($M= 4.75$, $SD= 0.82$) in masculinity than the gay composite ($M= 4.07$, $SD= 0.65$) ($t(71) = -5.28$, $p < .001$, $d= 0.62$). By contrast, the gay composites received significantly higher ratings ($M= 4.89$, $SD= .85$) in femininity than the heterosexual composite ($M= 3.39$, $SD = 0.67$) ($t(71) = 10.25$, $p < .001$, $d= 1.21$).

Similarly, when rated by women the heterosexual composites received significantly higher ratings ($M= 4.90$, $SD= 0.81$) in masculinity than the gay composite ($M=4.22$, $SD= 0.71$) ($t(235) = -9.98$, $p < .001$, $d= 0.65$). By contrast, the gay composites received significantly higher ratings ($M= 5.00$, $SD= 0.78$) in

femininity than the heterosexual composite ($M= 3.35$, $SD= 0.77$) ($t(235) = 20.76$, $p < .001$, $d= 1.35$).

Analysis of ‘specific masculinity’ and ‘specific femininity’.

The second set of analyses considered differences between the gay and heterosexual composite images in perceptions of masculinity and femininity as named variables. In response to the question, ‘How masculine is this man?’ the heterosexual composites received significantly higher ratings ($M= 5.56$, $SD= 1.18$) than the gay composite ($M=3.67$, $SD= 1.33$) ($t(307) = -18.79$, $p < .001$, $d= 1.07$). By contrast, in response to the question, ‘How feminine is this man?’ the heterosexual composites received significantly lower ratings ($M= 2.35$, $SD= 1.12$) than the gay composite ($M= 4.92$, $SD= 1.55$) ($t(307) = 24.10$, $p < .001$, $d= 1.37$).

The data were then analyzed by gender of participant. When rated by men, in response to the question, ‘How masculine is this man?’ the heterosexual composites received significantly higher ratings ($M= 5.39$, $SD= 1.16$) than the gay composite ($M=3.51$, $SD= 1.23$) ($t(71) = -9.39$, $p < .001$, $d= 1.11$). By contrast, in response to the question, ‘How feminine is this man?’ the heterosexual composites received significantly lower ratings ($M= 2.46$, $SD= 1.13$) than the gay composite ($M= 4.93$, $SD= 1.37$) ($t(71) = 11.87$, $p < .001$, $d= 1.40$).

Similarly, when rated by women, in response to the question, ‘How masculine is this man?’ the heterosexual composites received significantly higher

ratings ($M = 5.61$, $SD = 1.19$) than the gay composite ($M = 3.72$, $SD = 1.35$) ($t(235) = -16.26$, $p < .001$, $d = 1.06$). By contrast, in response to the question, ‘How feminine is this man?’ the heterosexual composites received significantly lower ratings ($M = 2.31$, $SD = 1.12$) than the gay composite ($M = 4.92$, $SD = 1.61$) ($t(235) = 21.06$, $p < .001$, $d = 1.37$).

Analysis of attractiveness.

Paired samples t -tests were performed to investigate perceived physical attractiveness of the gay and heterosexual composites. When analyzed as a group the gay composite was rated as more physically attractive ($M = 4.95$, $SD = 1.63$) than the heterosexual composite ($M = 3.94$, $SD = 1.62$) ($t(307) = 8.52$, $p < .001$, $d = 0.49$). When analyzed by gender women rated the gay composite as more physically attractive ($M = 5.11$, $SD = 1.59$) than the heterosexual composite ($M = 3.95$, $SD = 1.59$) ($t(235) = 8.48$, $p < .001$, $d = 0.55$). Similarly, men also rated the gay composite to be more physically attractive ($M = 4.44$, $SD = 1.67$) than the heterosexual composite ($M = 3.93$, $SD = 1.74$) ($t(71) = 2.25$, $p < .05$, $d = 0.44$).

Study 2

Method

Collection of images.

Images were collated from the internet of 219 gay men and 209 heterosexual men, all through open-access sites. An initial list of gay men was compiled through the LGBT link on a website providing lists of people based on a range of specific criteria (www.ranker.com). This particular site had the

advantage of including occupation (see below). Individuals were then verified through further searches, with inclusion requiring independent verification of sexuality through either evidence of co-habitation with a man as a partner or through self-declaration of homosexuality. If contradictory or insufficiently clear evidence was apparent the individual was not included in the sample. Images of the gay men were collated first to allow matching for occupation in the heterosexual group on the premise that certain occupations may attract more masculinized or more feminized men. A list of possible heterosexual men was then compiled through searches for men by occupation (e.g. male actors, male politicians etc.), and assignation of sexuality was again made through evidence of either current or past romantic relationships. Again, if contradictory or insufficiently clear evidence was apparent the individual was not included in the sample. Whilst, inevitably, such a sample may permit a false classification, nevertheless it is believed that the rigorous vetting involved should have kept erroneous classifications to a minimum.

Materials, apparatus and procedure.

Due to the sampling method we were unable to take photographs under standardized conditions. Nevertheless, in view of the need for exact facial measures, strict inclusion criteria were established based on those set by Hughes and Bremme (2011). Specifically, all photographs had to have sufficient clarity to be able to pick out landmark features with ease, as in the previous study they had to depict the individual facing forwards, with no head slant either laterally or in an

upward or downward position, and the individual had to be depicted with a neutral facial expression. Photographs with individuals wearing glasses (unless allowing sight of the facial markers required) were not used, nor were photographs of individuals with hairstyles concealing these markers. Lastly, and as recommended by LeFèvre et al (2012), all images were of Caucasian men in order to avoid the inherent problems of differing face shapes from mixed ethnicity samples.

Once the database of images had been collated, faciometric measurements were taken using the software ImageJ, an open-source, Java written program allowing analysis of scientific images (Schneider, Rasband, & Eliceiri, 2012). Five previously established faciometrics of sexual dimorphism were taken as follows: (1) Cheekbone prominence ($a-b/c-d$), (2) Facial width to lower face height ($a-b / e-f$), (3) Lower face height to Full face height ($e-f / e-g$), (4) Lip width to height ratio ($h-i/j-k$) and (5) Eye Mouth Eye angle (see Fig.2). Of these, eye mouth eye angle been less utilized in faciometrics research, however, it is an interesting ratio as it has been found to be both sexually dimorphic (Danel & Pawlowski, 2007), and the first area of interest in both face recognition (Maurer, Grand, & Mondloch, 2002) and in assessment of attractiveness (Hassebrauck, 1998).

In terms of sexual dimorphism in cheekbone prominence, women tend to show greater cheekbone prominence than men (Hughes & Bremme, 2011, Little et al, 2008; Penton-Voak, Jones, Little, Baker, Tiddeman, Burt & Perrett, 2001;

Robertson, Kingsley & Ford, 2017), as well as greater facial width to lower face height (Hughes & Bremme, 2011; Lefèvre, Lewis, Bates, Dzhelyova, Coetzee, Deary, & Perrett, 2012; Little et al, 2008; Penton-Voak et al, 2001; Robertson et al, 2017) and eye mouth eye angle (Danel & Pawlowski, 2007). Men, however, tend to show a greater lip width to height (Farkas, 1981; Ferrario, Sforza, Pizzini, Vogel & Miani, 1993; Fink, Grammer, Mitteroecker, Gunz, Schaefer, Bookstein & Manning, 2005; Penton-Voak, Little, Jones, Burt, Tiddeman, & Perrett, 2003) as well as a greater lower face height to full face height ratio (Hughes & Bremme, 2011; Lefèvre et al, 2012; Little et al, 2008; Penton-Voak et al, 2001), though it is noted that Robertson et al (2017) found that sexual dimorphism was only significant in this metric for those in their twenties and lost significance through aging.

Data analyses.

In order to obtain standardized masculinity/ femininity scores, all scores were initially converted to z -scores. A composite measure was then computed by totaling all metrics in which greater dimorphism indicated feminization, and then deducting all metrics in which greater dimorphism indicated masculinization. Thus, greater scores in the composite $([ChP + EME + FW/LFH]) - [LFH/FH + Lip Size])$ indicated a greater degree of femininity. A t -test was first used to assess morphological difference in masculinity/ femininity in the composite measure between gay and heterosexual men. MANOVA was then employed to investigate differences between gay and heterosexual men in the five

dependent variables, cheekbone prominence, facial width to lower face height, lower face height to full face height, lip width to height ratio and eye mouth eye angle. Alpha was set to .05 (though see note below) and p values presented are two-tailed.

Results

Descriptive statistics for gay and heterosexual faciometrics are shown in Table 1. Whilst checking conformation to the appropriate assumptions, it was noted that there were a number of outliers. Extreme outliers were therefore removed (representing eight faces) and the remaining outliers were converted to the mean plus or minus two standard deviations as per guidelines by Field (2009). Levene's Test also indicated a violation of homogeneity of variance for both cheekbone prominence and lip width to height ratio, and a more conservative alpha of .01 for these variables was therefore set.

A t -test investigating differences in the masculinity/ femininity of the faces indicated greater feminization in gay men ($M = 0.62$; $SD = 2.21$) than in heterosexual men ($M = -0.65$; $SD = 2.42$) ($t(418) = -5.53$, $p < .001$, $d = 0.55$). A one-way MANOVA revealed a significant difference in the sexually dimorphic faciometrics of gay and heterosexual images (Wilks' $\lambda = .76$, $F(5, 414) = 25.78$, $p < .001$, with partial $\eta^2 = 0.24$). Examination of the univariate analyses showed significant effects for cheekbone prominence ($F(1, 418) = 71.58$, $p < .001$, partial $\eta^2 = .15$), facial width to lower facial height ($F(1, 418) = 5.10$, $p = .024$, partial η^2

= .012), lip width to height ratio ($F(1, 418) = 32.34, p < .001$, partial $\eta^2 = .07$) and eye mouth eye angle ($F(1, 418) = 3.93, p = .048$, partial $\eta^2 = .01$). Lower facial height to full facial height, however, failed to reach significance ($F(1, 418) = .01, p = ns$, partial $\eta^2 < .001$).

Discussion

Consistent with the hypotheses, both studies showed evidence of a more feminized facial phenotype in gay men as compared to heterosexual men. In the first study, significant differences were seen in perceptions of the characteristics of the averaged faces, with the gay face being rated as significantly lower in masculine characteristics than the heterosexual face and significantly higher in feminine characteristics, and this was true of both male and female participants. Importantly, participants were naïve to the nature of the images in this study (i.e. that they were composite images of gay and of heterosexual men), and therefore decisions regarding the masculinity/ femininity of both should not have been overtly influenced by cultural stereotyping, though it is accepted that considerations about sexuality may have been taking place at either a conscious or sub-conscious level.

In the second study, faciometrics were used in the objective investigation of specific facial dimensions known to be sexually dimorphic in human faces. The aim was to corroborate the findings of the first study, and to assess whether increased perceived femininity, if found, would be explained at a gestalt level (as seen by Hughes and Bremme, 2011), or, perhaps additionally, by individual,

sexually-dimorphic, trait measurements. As predicted, the faciometrics of gay men were shown to be significantly more feminine, with a medium effect size, than the faciometrics of heterosexual men in the composite measure, consistent with the gestalt perception of masculinity/ femininity noted by Hughes and Bremme (2011).

In addition, however, the current study was also able to determine differences between gay and heterosexual men in individual, sexually-dimorphic, trait measurements. Specifically, differences were seen in the predicted directions in cheekbone prominence and lip width to height ratio, as well as the more novel eye mouth eye angle as previously demonstrated by Danel and Pawlowski (2007). In terms of effect size, cheekbone prominence showed a large effect, consistent with the findings of Robertson et al (2017) who argue for cheekbone prominence as the most reliable measure of sexual dimorphism across all ages. There was a medium effect size for lip width to height ratio, whereas the effect size for eye mouth eye ratio was small. The latter finding, though small, is supported by the findings of Rule et al (2008), that not only hairstyle but also the eye and mouth area may be used in the accurate (if not perceived accuracy of) assessment of male sexual orientation.

Facial width to lower facial height was also significant, though with a small effect size. It was not, however, significant in the direction predicted. In fact, counter to predictions of femininity in gay men which would involve a greater width to height ratio (Hughes & Bremme, 2011; Lefèvre, Lewis, Perrett &

Penke, 2013; Little et al, 2008; Penton-Voak et al, 2001; Robertson et al, 2017), this study showed gay men to have a more masculine facial width to height ratio than heterosexual men. Although counter to expectation, Lefèvre et al (2013) also note that facial width to lower facial height ran counter to their expectations with this metric showing more masculine-typical scores being associated with lower testosterone levels, and this may be explained by the differential effects of prenatal hormones as well as chromosomal gender on characteristics assumed to be ‘masculine’ or ‘feminine’ (Fink et al, 2005). It is possible that the shorter philtrum seen in heterosexual men as compared to gay men as noted in the Valentova et al study (2014) could account for the finding in both the Lefèvre et al and the current study. Similarly, despite lower face height to full face height being regarded as sexually dimorphic trait (Hughes & Bremme, 201; Penton-Voak et al, 2001), no significant difference was found in this study. It should be noted, however, that qualitative analysis of geometric morphometrics conducted by Valentova et al indicated that phenotypic difference may not be simply an artifact of variation in femininity (although femininity is supported by the medium effect size in the composite measure in the current study). Rather, they suggest, differences may be a more complex ‘mosaic’ of masculine and feminine features and positioning, as supported by the large effect size in the multivariate analysis of the current study. Thus it seems likely that, whilst generally more feminized, the individual facial ratios of gay men may be rather more nuanced than a simple sexually-dimorphic account would indicate.

Whilst the primary focus of these investigations was the possible feminization of the gay male face, the first study provided a useful opportunity to consider the reported physical attractiveness of the gay versus the heterosexual face. In this study the gay face was rated as significantly more attractive than the heterosexual face by both male and female raters. In view of the feminization also perceived, this is consistent with the finding that women prefer more feminized facial features in men (Perrett et al, 1998; Rhodes, Hickford & Jeffrey, 2000) and the argument that such preference may be associated with either putative or actual feminine and desirable personality traits. However, it is noted that this research is equivocal, with other studies showing links between masculinity and attractiveness (e.g. Cunningham, Barbee & Pike, 1990; Johnston, Hagel, Franklin, Fink & Grammer, 2001; Scheib, Gangestad & Thornhill, 1999), and is therefore worthy of continued investigation. Specifically, with regard to this research, this particular question might receive useful clarification by considering menstrual cycle and fertility issues alongside judgments of physical attractiveness.

The studies, though providing support for phenotypic facial feminization, are not without their limitations. It is recognized, for example, that accurate judgments may be made with only very thin slices of information (Freeman et al, 2010; Rule & Ambady, 2008). Thus, whilst participants were intentionally kept naïve to the nature of the first study, being asked to rate images (without further information) for personality characteristics, they may, nonetheless, have made judgments about the sexuality of the composites at either a conscious or sub-

conscious level which may then have influenced subsequent judgments. It is hoped, however, that any conscious sub-cultural stereotyping was kept to a minimum through the deliberate decision to restrict full information until conclusion of participation, representing a departure from previous studies in which raters were conscious of sexuality as a focus of interest.

Nevertheless, the current studies provide converging support with regard to phenotypic facial feminization in gay men, consistent with heterozygote advantage, sexual antagonism and same-sex affiliation theory, thus endorsing the view that one must look beyond our 'cultural knowledge' of what it is to be gay (Freeman, Johnson, Ambady & Rule, 2010) to discernible biological cues if one is to gain a more complete understanding of the complex etiology of male homosexuality.

In conclusion, our investigations of facial feminization in gay men, employing both composite images and faciometric analyses (at both a gestalt and specific faciometric level), are consistent with three of the predominant explanatory theories for a biological etiology of at least one sub type of male homosexuality. This paper does not attempt to provide conclusive evidence for one explanatory theory over another. It does, however, provide support for further investigation in this controversial area.

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